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ORIGINAL CONTRIBUTION

Surgical Management of Pressure Ulcers During Inpatient Neurologic Rehabilitation: Outcomes for Patients With Spinal Cord Disease

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Received November 20, 2007; accepted October 17, 2009

Abstract

Background/Objective: To study efficacy of surgery in the management of pressure ulcers and evaluate the effect of simultaneous comprehensive rehabilitation in improving outcome.

Method: Prospective, follow-up study.

Setting: Neurologic rehabilitation unit of a tertiary care center.

Participants: Patients with spinal cord diseases who had stage III/IV pressure ulcers underwent surgical reconstruction and inpatient rehabilitation in 2005 with a minimum follow-up duration of 1 year.

Outcome Measures: Ulcer healing rate, postoperative complications, ulcers recurrence rate, and neurologic (ASIA grade), and functional recovery (Barthel Index).

Statistical Analysis: Frequency analysis and paired *t* test on SPSS 13.0.

Results: Surgical intervention was carried out in 25 participants (19 men, 6 women), having a total of 39 ulcers (13 Stage III, 23 Stage IV, 3 unstaged). Surgeries performed were debridement (3), split skin grafting (13), and flap mobilization and closure (23). Only 4 participants (16.6%) had initial complications: wound dehiscence (2) and delayed graft healing (2). Follow-up rate was 92.0% (23/25 patients), with a duration of 12 to 21 months (mean, 15.4 $\pm$ 7.45 months), and only 4 participants (17.3%) had ulcer recurrence. The majority of participants (13 of 25; 56.5%) improved neurologically on ASIA grade and functional evaluation on Barthel Index, suggesting statistically significant improvement ($P < 0.005$).

Conclusions: All outcome variables showed significant improvement at follow-up with good ulcer healing rate (87.0%), low initial complication (16.6%) and recurrence rates (17.3%), and good neurologic (56.5%) and functional ($P < 0.005$) recovery. Timely surgical interventions are necessary for Stage III to IV pressure ulcers, and simultaneous inpatient rehabilitation significantly improves outcome of patients with spinal cord disease.

J Spinal Cord Med. Apr 2009;32(2):125–131

Key Words: Spinal cord injuries; Myelopathy, transverse; Pott's spine; Pressure ulcer; Paraplegia; Tetraplegia; Rehabilitation; Reconstructive surgery; Flap surgery; Debridement; Skin graft; Outcomes; Barthel Index; Braden Scale; National Pressure Ulcer Advisory Panel

INTRODUCTION

Pressure ulcers have afflicted humans since antiquity. Overall, 85% of people with spinal cord disorders develop pressure ulcers during their lifetime and approximately 8% die from them (1). Pressure ulcers increase length of stay, escalate the cost of treatment, and impair quality of life. Various physical, pharmacologic, and surgical methods have been tried in the treatment of pressure ulcers. Sir John Staige Davis is credited with being the first to attempt surgical cure of pressure ulcers (2). Now, several decades later, many options are available for surgical management of pressure ulcers, including direct closure, skin grafting, skin flaps, and musculocutaneous flaps (3). Immediate postoperative complications and ulcer recurrence rates at follow-up have been remarkably high, particularly in patients with spinal cord injury (SCI) (4–6). These high incidences can be reduced by comprehensive care provided by the rehabilitation team (5). Not much literature is available on the effect of pressure ulcer healing on neurologic and functional recovery in patients with SCI.

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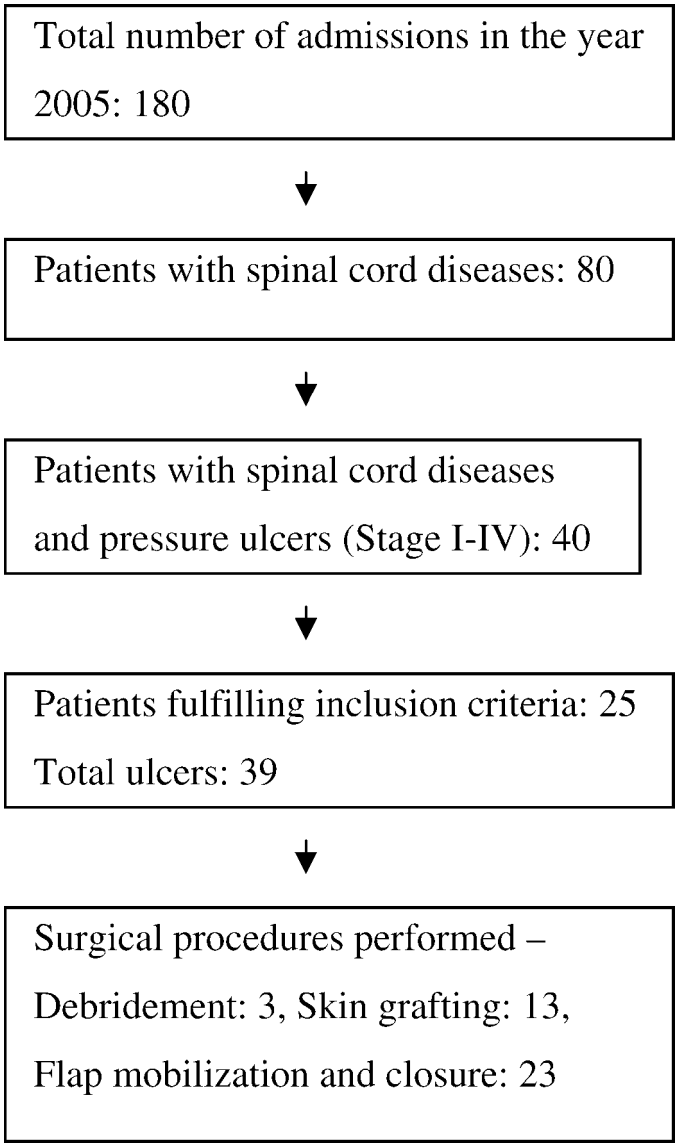

Figure 1. *Flow chart showing patients included in the study.*

The aim of our study was to determine the efficacy of surgical interventions in the management of pressure ulcers in patients with spinal cord dysfunction and to evaluate the effect of simultaneous inpatient rehabilitation in improving neurologic and functional outcome.

METHODS

This prospective study was conducted in the Department of Psychiatric and Neurological Rehabilitation, National Institute of Mental Health and Neurosciences (NIMHANS), Bangalore, India. Participants were patients with spinal cord disorders who were admitted to the neurological rehabilitation ward with pressure ulcers within the 1-year period of January through December 2005 with Stage III/IV/unstaged pressure ulcers. Pressure ulcers were categorized per the National Pressure Ulcer Advisory Panel (NPUAP 2007) (7). Patients with ulcers from other causes or a primary site of pathology other than the spinal cord were excluded.

Table 1. Etiology of Spinal Cord Disorders (N = 25)

Diagnosis	No. of Patients
Transverse myelitis	7
Spinal tuberculosis	6
Spinal cord trauma	5
Spinal tumors	3
Ossified posterior longitudinal ligament	2
Lumbar meningomyelocele	2

Sociodemographic and clinical information was obtained in a predesigned format. Sociodemographic information included age, sex, primary illness, and Braden pressure ulcer risk assessment scale (8). Clinical examination was done according to the guidelines of the International Standards for Neurological Examination and Functional Classification of Spinal Cord Injury (ASIA Grade) (9). The data collected for pressure ulcers were number, site, duration, and staging of each ulcer. Functional ability was assessed using the Barthel Index. All ulcers were photographed preoperatively, postoperatively, after suture removal, and at follow-up.

The principle of management was to treat not only the ulcer but the patient as a whole. Intervention was divided into 3 continuous stages of preoperative, operative, and postoperative management. Preoperative management consisted of nursing care, bedside sharp debridement and dressing, and education regarding ulcer care. Operative interventions were decided on the basis of ulcer stage and presence/absence of eschar: Stage III/IV/unstaged necrotic wounds—debridement; Stage III clean and granulating—skin grafting; and Stage IV clean and granulating—local flap mobilization and primary closure. Postoperative management consisted of continuous negative pressure by suction drain for 48 to 72 hours and appropriate wound hygiene. Sutures were removed on postoperative day 10, followed by gradual mobilization and weight bearing on the affected part. All patients underwent simultaneous comprehensive inpatient rehabilitation consisting of daily physiotherapy, occupational therapy, and orthotic intervention (knee-

Table 2. Site of Pressure Ulcers

Site	No. of Patients
Sacrum	13 (33.3%)
Gluteal region	9 (23.0%)
Greater trochanter	8 (20.5%)
Ischial tuberosity	4 (10.2%)
Heel	2 (5.1%)
Sole of foot	2 (5.1%)
Dorsum of ankle	1 (2.5%)

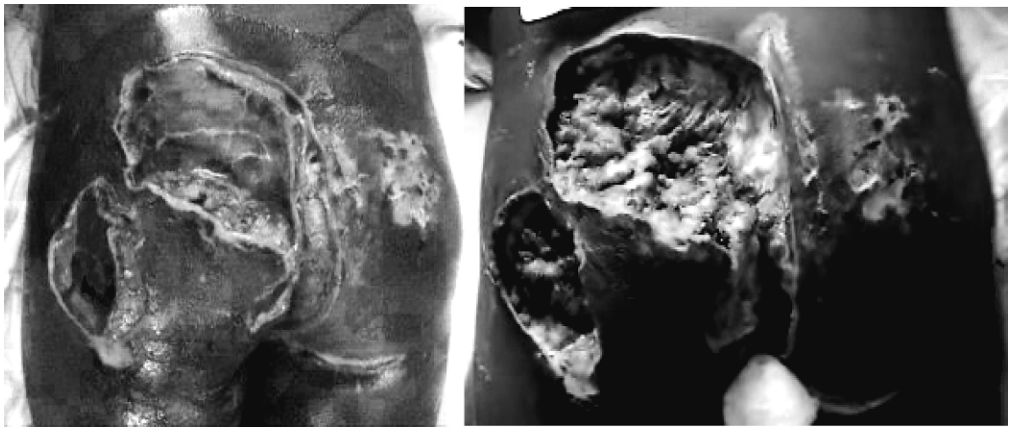

Figure 2. *Large sacral ulcer—before and after debridement.*

ankle-foot orthosis or ankle-foot orthosis) as per individual patient needs and psychosocial counseling.

Postoperative complications recorded were wound dehiscence, graft failure, and bleeding. At follow-up, ulcer recurrence and neurologic examination and functional evaluation were recorded. All recordings were done by a single evaluator. Outcome measures were initial complications after surgery, ulcer healing and recurrence rate, and neurologic and functional recovery expressed as percentages of the total. Paired *t* test was used for evaluating functional recovery at discharge and follow-up (significance value, $P < 0.05$). Statistical analysis was done on SPSS13.0 for Windows.

RESULTS

Of 180 persons admitted in the neurological rehabilitation ward during the study period, 45 had pressure ulcers at the time of admission. Twenty-five patients (19 men and 6 women; 22 with paraplegia and 3 with tetraplegia) satisfied the inclusion criteria for the study (Figure 1). Ages ranged from 13 to 45 years (mean, 27.6 $\pm$ 7.45 years). Etiology of the spinal cord lesions is given in Table 1. Neurologic evaluation on ASIA scale was as follow: Grade A, 20 (80%); Grade B, 3 (12%); Grade C, 2 (8%); Grade D, 0; Grade E, 0. Pressure ulcer risk assessment on the Braden scale showed that 22 (88.0%) participants were in the high-risk category (score $<$ 16), whereas the remaining 3 (12%) had low risk (score $>$ 16). Functional evaluation on the Barthel Index showed scores ranging from 5 to 75 (28.6 $\pm$ 16.68).

A total of 25 participants (39 ulcers) were included in the study: 16 participants (64.0%) had a single pressure ulcer, whereas 9 (36.0%) had multiple ulcers (5 [20.0%] particpants had 2 ulcers, 3 [12.0%] had 3 ulcers, and 1 [4.0%] participant had 4 ulcers). Number of ulcers by stage at beginning of the study was as follows: Stage III, 13 (33.3%); Stage IV, 23 (58.9%); unstaged, 3 (7.6%). Number and location of these ulcers are given in Table 2. Most ulcers (20 of 39 [51.2%]) evolved in the acute care facility, 15 (38.4%) evolved at home, and 4 (10.2%) evolved in the rehabilitation ward.

Surgical procedures carried out were as follows: debridement, 3 (7.6%); skin grafting, 13 (33.3%); flap mobilization and closure, 23 (58.9%). Single-stage debridement was done in 3 patients under monitored anesthetic care because of large sacral ulcers with significant necrotic tissue (Figure 2). Two of these patients were referred to a general medical facility for management of the associated comorbidities, and their ulcers were not healed at the time of referral. Split-skin grafting was done for 13 ulcers: 5 sacral, 3 gluteal, 2 heel, 2 sole, and 1 ankle ulcer (Figure 3). Two grafts became infected with methicillin-resistant *Staphylococcus aureus*, which was managed by meticulous care and appropriate

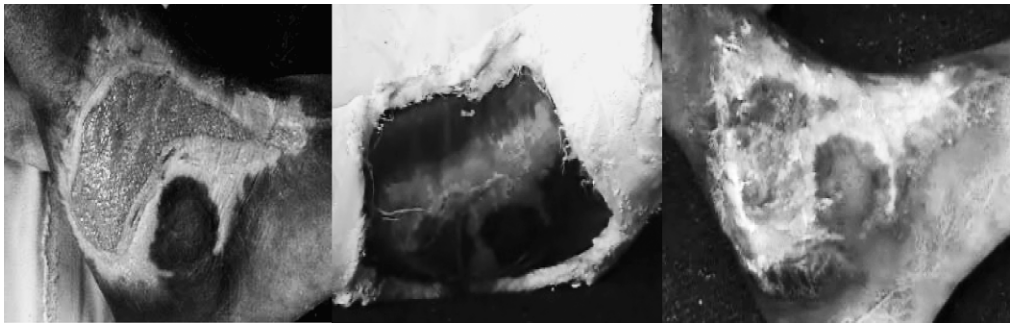

Figure 3. *Split skin grafting (sequence of events).*

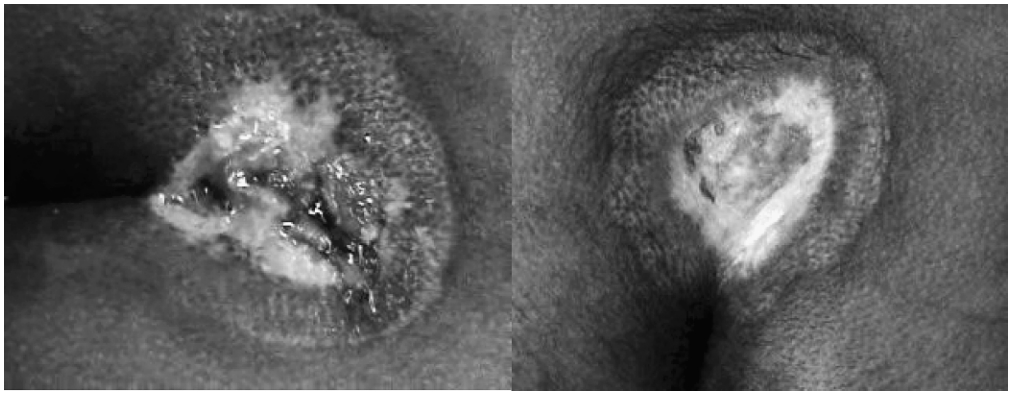

Figure 4. *Graft MRSA infection (before and after management of infection).*

antibiotics (Figure 4). Both of these grafts took longer to heal.

Local flap mobilization and primary closure was done in 23 ulcers: 8 trochanteric, 6 gluteal, 5 sacral, and 4 ischial (Figure 5). Two flap procedures had a suture line dehiscence as a result of the hematoma formation and excessive tension on the suture line (Figure 6). One of them required repeat closure, whereas the other healed with conservative management. Therefore, postoperative complications occurred with 4 (10.2%) ulcers, and consequently, healing time was prolonged in these 4 ulcers. Among the remaining 33 ulcers, the average healing time for grafting procedures was 35.5 days, whereas for flap mobilization and closure, it was 20.5 days. At the time of discharge from the rehabilitation unit, 37 ulcers (94.8%) were healed. Average time for starting sitting after surgery was 28 days; sitting was delayed longer for those who underwent grafting procedures than for those with flap surgery.

Length of stay varied from 16 to 269 days (97.36 $\pm$ 66.47 days) and was longer for those with traumatic lesions (180.55 $\pm$ 65.45) compared with those with nontraumatic spinal cord pathology (134.71 $\pm$ 42.34; Figure 7). Functional evaluation on the Barthel Index showed significant improvement, with scores ranging from 25 to 100 (67.00 $\pm$ 16.95).

All participants were prospectively followed, but 2 were lost to follow-up. Follow-up duration ranged from 12 to 21 months (mean, 15.4 $\pm$ 7.45 months). Compared with preoperative neurologic status, 13 of 23 (56.5%) patients had significant neurologic recovery at follow-up. Neurologic evaluation at follow-up showed the following: ASIA Grade A, 5 (21.7%); Grade B, 1 (4.3%); Grade C, 2 (8.6%); Grade D, 15; Grade E, 0 (Figure 8). Similarly, functional evaluation on the Barthel Index showed significant functional recovery, with scores ranging from 25 to 100 (74.61 $\pm$ 23.97; Figure 9). Ulcer recurrence was seen in 4 (17.3%) participants: 3 (13.0%) had recurrence at the same site (all 3 had spinal cord injury and had a skin graft), whereas 1 (4.3%) had a new ulcer at different site (ischial). Ulcer healing rate was 87%; 20 of 23 participants had no local recurrence at the same site. Ulcer-free rate was 82.7%; 19 of 23 participants had no new ulcer at follow-up.

DISCUSSION

Wound care can be divided into nonoperative and operative methods. The surgical approach and management techniques have changed over the years and are well accepted now. Some of these changes include reduction in the length of in-hospital stay, wound debridement methods, and the reduction in pre- and postoperative immobilization period (10). In our study, 6 (24%) participants were admitted a week before surgery, whereas in the other 19 (76%) patients, the admission to operative interval was longer because of comorbidities.

The decision to use a particular flap or type depends on the surgeon's expertise and the size and position of

Figure 5. *Local flap mobilization and primary closure (sequence of events).*

Figure 6. *Wound dehiscence after primary closure (sequence of events).*

the ulcer (3). The local flap mobilization with primary closure method performed in our study is a modification of double opposing semicircular flap and closure for circular defects as advocated by Keyser et al (11). Schryvers et al (12), in a study of 65 pressure ulcers managed by primary closure, reported an average healing time of 65.3 days, which was much higher than in our study (25.91 days). The shorter healing time in our study might be caused by the type of surgical procedure done (double opposing semicircular flap and closer technique) and smaller size of the ulcers.

Suture line dehiscence and graft failure are the most common complications after pressure ulcer surgery. In a 17-year review of surgical treatment of 280 pelvic area pressure ulcers in populations of people with spinal cord injuries, Foster et al (13) found an overall 28% initial complication rate and 17% reoperation rate. Similarly, high complication rates of 36% and 42% have been reported by Disa et al (6) and Schryvers et al (12), respectively. In our study, wound dehiscence and graft failure were noted in 2 cases each, all but 1 healed by conservative means, for which re-operation and closure was required, leading to initial complication rate of 10.2% and reoperation rate of 2.6%. Aggarwal et al (14) in a study of 34 patients with SCI also reported a lower (11.4%) incidence of complications.

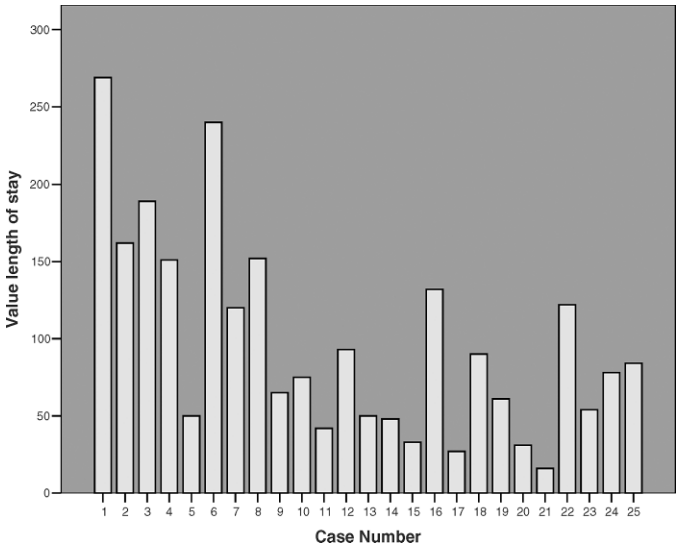

Figure 7. *Length of stay for inpatient rehabilitation.*

Postsurgical pressure ulcer recurrence is a relative common occurrence, and successful outcomes are measured as complete closure at follow-up. Relander and Palmer (4) reported a 48% recurrence rate for 66 surgically treated ulcers, with a follow-up ranging from 2 to 12 years postoperatively. Similarly, Disa et al (6) described a 61% recurrence rate at an average of just 9.3 months after reconstruction of 66 pressure ulcers. In fact, these dramatic statistics prompted the authors to question the validity of such reconstruction procedures.

Kirney et al (5), in their 12-year review of 158 subjects with 268 pressure ulcers, found a 19% ulcer recurrence rate at the same site, which is comparable with our study of 17.3%. Similarly, low ulcer recurrence rates of 11.3% and 22% were also reported by Aggarwal et al (14) and Bilkay et al (15). In our study, the recurrence rate was high among the subset of patients who underwent skin grafting procedures. In the treatment of pelvic area pressure ulcers, grafting has a useful but limited value because the graft does not tolerate pressure well (12). As noted by Kirney et al (5), active participation of the rehabilitation team in perioperative care is important. The whole patient, not just the ulcer, must be considered, because many physical and psychosocial factors need to be evaluated and treated to optimize healing and prevent recurrence. Length of stay varied from 16 to 269 days (97.36 $\pm$ 66.47 days), which was not higher considering it included the time spent on management of secondary complications, preparation for surgery, healing time, and functional abilities and gait/wheelchair training. Length of stay was longer in patients with traumatic SCI compared with those with nontraumatic spinal cord lesions.

Little has been written about the relationship between presence/healing of pressure ulcers and neurologic and functional recovery. In our study, 56.5% (13 of 23) of participants had neurologic recovery at the time of follow-up, manifested by change in ASIA grade. Neurologic recovery was better in patients with nontraumatic spinal cord lesion, that is, transverse myelitis (4/7 patients, 57.1%) and Pott's spine (5/6 patients, 83.3%), which might be because of the nature of the pathology and the degree of spinal cord damage. Recovery was

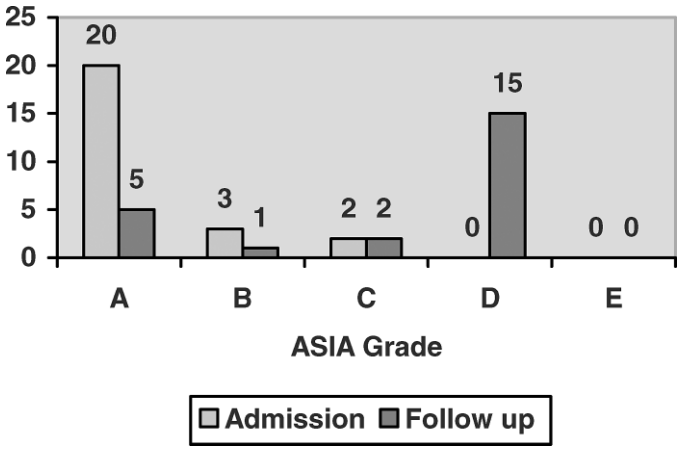

Figure 8. *Neurologic status by ASIA grade at the time of admission to rehabilitation unit and follow-up.*

poor in patients with SCI (1/5, 20%) and spinal tumors (0/3) because of significant cord damage and because most of these patients were admitted late in the course of the disease. Neurologic recovery in our study was comparable with other studies: nontraumatic spinal cord lesion, 55 to 60% (16), Pott's spine, 88% (17), SCI, 23.1% to 27% (18,19). The contribution of timely surgical intervention and healing of pressure ulcers in neurologic recovery in patients with spinal cord lesions is debatable because recovery may be a natural and spontaneous process considering the natural history of the disease.

All patients in our study had functional recovery as manifested by statistically significant improvement in Barthel Index scores at discharge from the rehabilitation unit and at follow-up. Functional recovery was better in nontraumatic spinal cord lesion, for example, for transverse myelitis ($P < 0.000$) and Pott's spine ($P < 0.000$). Whereas those with SCI had shown significant improvement ($P < 0.03$), the extent of improvement was not as good compared with that for people with nontraumatic lesions, as manifested by the low scores achieved at follow-up. McKinley et al (16) reported that study participants with nontraumatic spinal cord lesions can achieve similar functional outcome as gained by those with traumatic lesions. However, our findings are comparable to a recent study by Ones et al (20), who reported that functional evaluation scores at admission and gain in scores at discharge were lower in study participants with traumatic spinal cord lesions compared with those with nontraumatic spinal cord lesions. The higher rate of functional recovery in our study population can also be caused by supervised training and care provided by the combined and coordinated efforts of the rehabilitation team.

However, there are several limitations. This study had a limited sample size, and follow-up duration was short. Larger sample sizes and longer follow-up may provide a better understanding of the natural recovery from the spinal cord disease and rate of ulcer recurrence. There was selection bias in the study in terms of age at onset, level of lesion, and pattern of paralysis. Most of the patients were young adults with paraplegia, had better participation in the rehabilitation program, and became independent in ambulation, leading to better ulcer healing rate at follow-up. The etiology of the spinal cord lesions was heterogeneous in our study; however,

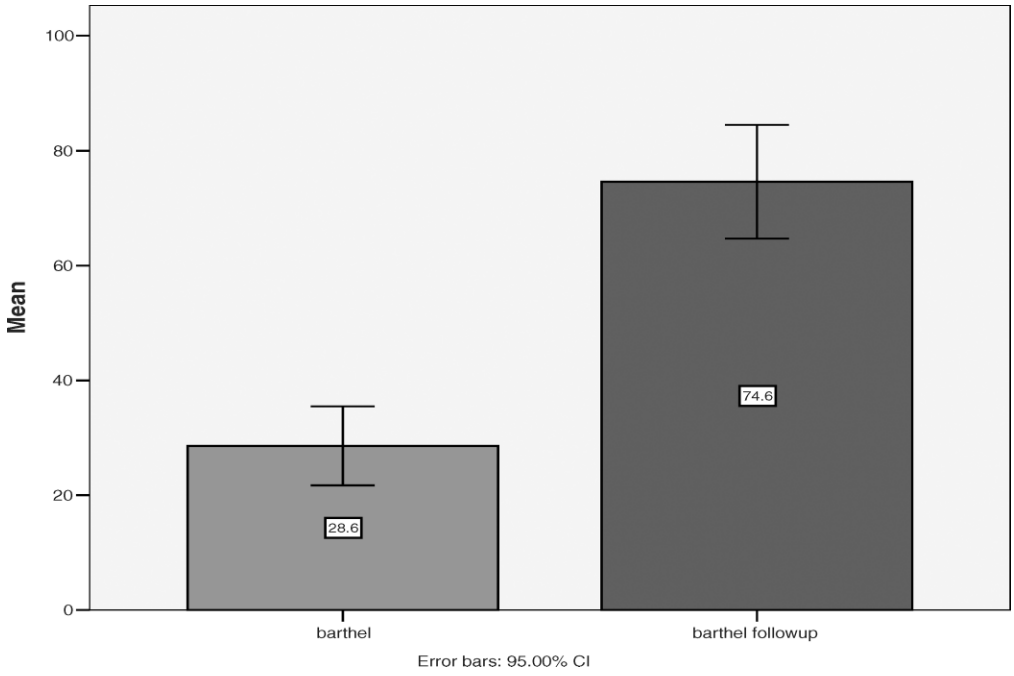

Figure 9. *Comparisons of functional evaluation by Barthel Index at admission to rehabilitation unit and at follow-up.*

outcomes would have been affected by patients with varying levels of lesions and if more participants had had tetraplegia. The actual contribution of the early healing of pressure ulcers by reconstructive surgery in augmenting neurologic recovery is still questionable because a controlled study can not be carried out for ethical reasons.

CONCLUSION

Surgical interventions play an important role in the management of pressure ulcer in patients with spinal cord lesions. Timely surgical interventions are necessary for Stage III to IV pressure ulcers. Reconstructive procedures are effective and should be an integral part of a rehabilitation program. Wound dehiscence is a common complication for various reasons. Ulcer recurrence occurs more often after skin grafting, if weight bearing is not prevented, and if there is no neurologic or functional recovery. The contribution of surgical interventions for pressure ulcers in augmenting neurologic recovery is debatable because this may represent spontaneous natural recovery from the neurologic illness.

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